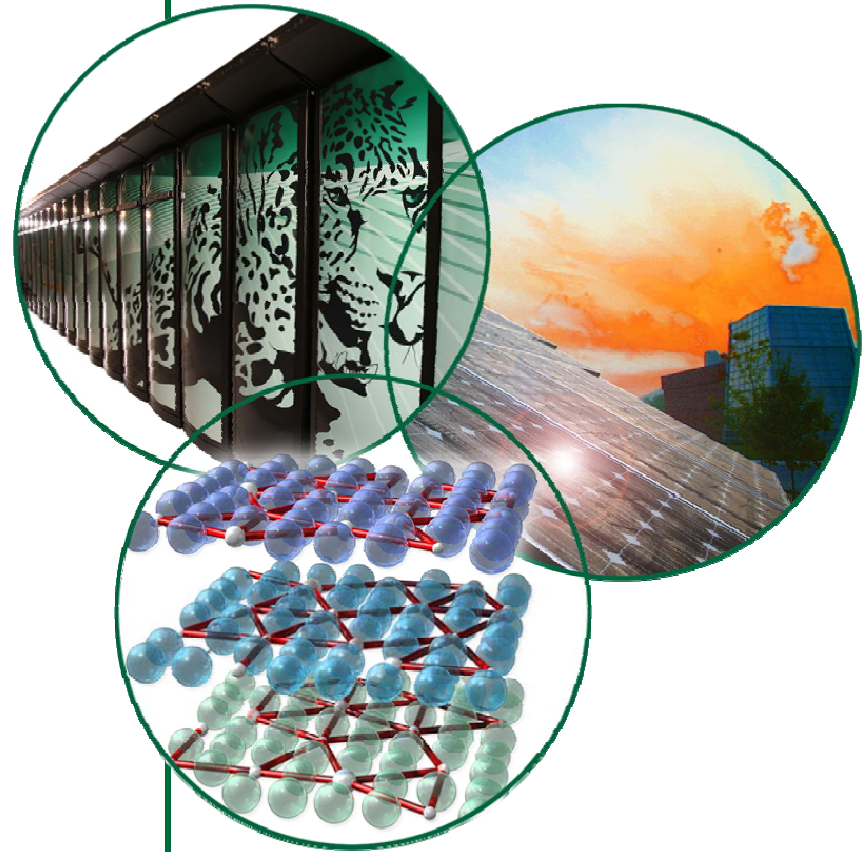


Guniting Tanks Waste Retrieval and Closure Operations at Oak Ridge National Laboratory

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ORNL Tank Waste Consolidation

- Purpose: Consolidation of waste from the active and inactive storage tanks to a single active waste storage tank system
 - Inactive Tanks
 - 12 Gunitite and Associated Tanks (GAAT)
 - 5 Old Hydrofracture Facility Tanks
 - Multiple Federal Facilities Agreement Tanks
 - Active Tanks
 - 5 Bethel Valley Evaporator Service Tanks (BVESTs)
 - 8 Melton Valley Storage Tanks (MVSTs)
 - 6 Melton Valley Capacity Increase Tanks



Waste Consolidation Tanks

Typical Sludge Characteristics

	Range	Average	Wt %
Density (g/mL)	1.169 – 1.675	1.343	
Water (wt%)	52.9 – 72.7	59.1	59.1
pH	8.7 – 12.0	10.1	
TOC (mg/kg)	2,300 – 13,400	7613	0.76
Ca (mg/kg)	23,400 – 73,700	49,825	4.98
Na (mg/kg)	23,700 – 48,000	39,225	3.92
U (mg/kg)	18,000 – 41,900	29,100	2.91
NO ₃ (mg/kg)	73,500 – 233,000	135,400	13.54
¹³⁷ Cs (Ci/gal)	0.0639 – 0.235	0.0989	
⁹⁰ Sr (Ci/gal)	0.0988 – 0.51	0.272	
G Beta (Ci/gal)	0.507 – 1.27	0.731	
G Alpha (Ci/gal)	0.00668 – 0.027	0.0136	

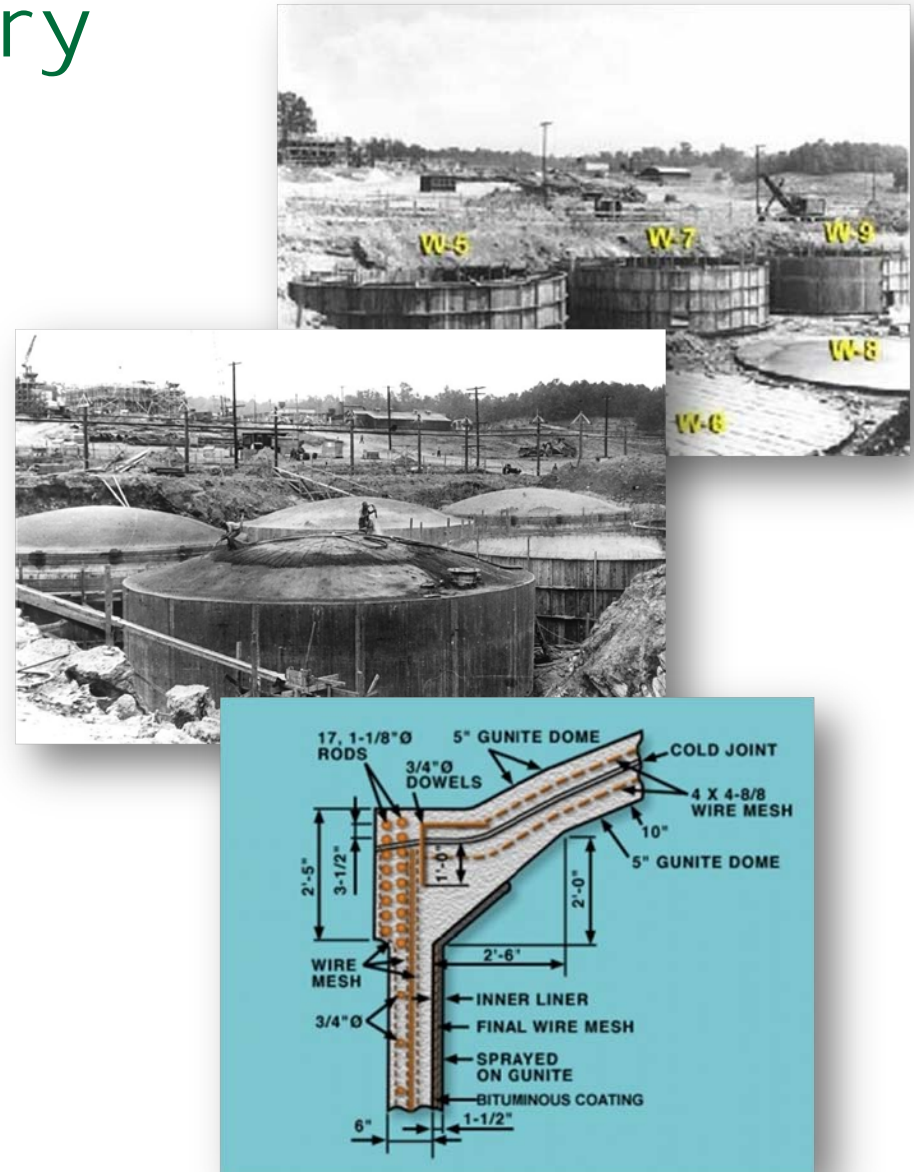
Waste Transfer Line

- **2 in. diameter SCH 40 Stainless steel pipe**
 - Double contained within 3 in. diam. SCH 40 pipe
- **Multiple elevation changes (~51 ft) between Bethel Valley Evaporator Service Tanks and Melton Valley Storage Tanks**
- **Over 1 mile long**
- **Moyno progressive cavity transfer pump or Discflo centrifugal transfer pump**
- **Waste Acceptance Criteria**
 - suspended solids <5 wt %
 - maximum particle of 100 μm



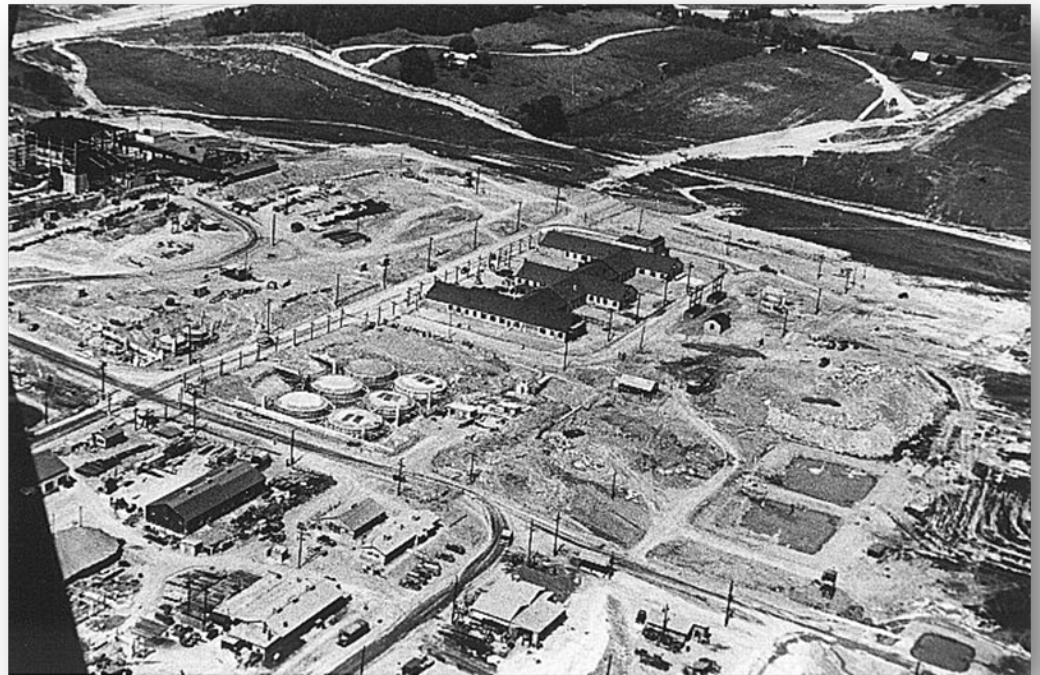
Gunitite Tanks History

- In 1943 twelve underground storage tanks were constructed of "gunitite" - a sand and Portland cement mixture sprayed over a wire mesh and reinforcing rod frame.
- The tanks were used to store wastes from "pilot scale" separation operations and research missions.
- The tanks were removed from service in the early 1970's.
- Most (~90%) of the accumulated sludge and liquid waste was removed during an 18 month campaign from 1982 through 1984.



Gunitite Tanks Project Goal

- Remove the remaining transuranic sludge (~94,000 gal) and supernatant waste from the 55-year old gunitite tanks located in the main plant area of Oak Ridge National Laboratory
- Consolidate the waste in the permitted Melton Valley Storage Tanks
- Address final closure



ORNL during construction - 1943

The GAAT Remediation Deployed Approximately 40 Technologies*

Sampling, Characterization, and Modification

- Floating boom In tank Camera & Sampling Device
- Ponar Sampling Tool
- Sludge Mapping Tool
- Topographical Mapping System
- Large Diameter Coring Saw for Tank
 - Riser Installation
- Remote Video Cameras & Lighting
 - Multiplexed Pan & Tilt Controller for multiple Cameras
- Gunitite Isotope Mapping Tool
- Characterization End-Effector
- Feeler Gauge
- Hydraulic Shears
- Pipe Cutting Saw
- Pipe Plugging Tool
- Wall Coring Tool
- Wall Scraping Tool

Waste Mixing

- Flygt Mixers
- PulsAir Mixers
- Russian Pulsating Mixer Pump

Sludge Heel Retrieval and Wall Cleaning

- Modified Light Duty Utility Arm
- Houdini I Remotely Operated Vehicle Houdini II Remotely Operated Vehicle
- Decontamination Spray Ring
- Waste Dislodging & Conveyance System
 - Confined Sluicing End-Effector
 - Hose Management Arm
 - Axial Flow Jet Pump
 - Flow Monitor & Sampling Device
- Gunitite Scarifying End-Effector
- High Pressure Pump for Wall Scarifying
- Gripper End-Effector Hydraulic Pump
- Linear Scarifying End-Effector

Waste Conditioning and Transfer

- In-line Sampler
- Waste Removal & Transfer System
- Sludge Conditioning System
 - Primary Conditioning System Module
 - In-Line Sampler
 - Size Classifier
 - Disc Flow Pump
 - Solids Monitoring Test Loop
 - Particle Size Analyzer
 - Ultrasonic Suspended Solids Monitor
- Coriolis Density Meter

* Refer to Lewis, B.E, et al., *The Gunitite and Associated Tanks Remediation Project Tank Waste Retrieval Performance and Lessons Learned*, ORNL/TM-2001/142/V1, Sept. 2003, for additional information.

The Gunite Tanks Remediation Project South Tank Farm Operations



Key Systems

- **Remote camera and lighting** – Served as the in-tank eyes of the equipment operators
- **MLDUA** – 8 degree-of-freedom robotic arm used to deploy tank characterization equipment, tank modification tools, and waste retrieval and wall-cleaning end-effectors
 - Gripper end-effector
 - Two cameras
 - 15-ft reach and 200-lb payload capacity
 - Operated remotely or via preprogrammed sequences
- **Houdini ROV** – 1000-lb tethered collapsible vehicle with a 4 x 5 ft expanded footprint that provided versatility during in-tank operations to deploy various tools and end-effectors
 - Track driven via hydraulic motors
 - 6 degree-of-freedom robotic arm and gripper end-effector with a payload capacity of 240 lb
 - On-board cameras
 - Plow blade for breaking up and pushing sludge
- **Waste Dislodging and Conveyance System** – Provided the capability to dislodge and retrieve waste, manage the in-tank hoses and lines, and deploy various tooling
 - Confined Sluicing End-Effector with rotating cutting jets
 - Jet pump vacuum source
 - Hose Management Arm



Heel Retrieval - Dewatering

The Confined Sluicing End-Effector (CSEE) was used in conjunction with the MLDUA and HMA to remove liquid waste in preparation for sludge mining



Heel Retrieval - Sludge Mining

High-pressure water (10 ksi) and rotating (0–500 rpm) cutting jets were used to dislodge the sludge



The jet pump removed sludge through a Flow Monitor and Sampling Device to a waste consolidation tank via a 2-in.-diam hose connected to the Hose Management Arm



Heel Retrieval - Sludge Mining



The Houdini was used to plow sludge toward the CSEE to improve sludge-mining operations



Typically, less than 1 in. of sludge remained in the tanks after sludge mining

Gunitite Tanks Status

- **January 2001 – Completed waste removal operations in the nine largest gunitite tanks**
 - Removed 439,000 gallons of waste (sludge and supernate) containing 82,000 curies
 - Sludge successfully transferred to the Melton Valley Storage Tanks
 - Completed waste retrieval operations ~5.5 years ahead of the original baseline schedule
 - Savings of over \$120 Million
- **Site demobilization completed**
 - Secondary waste has been containerized for disposal and equipment either reused or disposed
 - Tanks have been stabilized in place by filling with low-strength grout
 - Portland cement (2.2%), sand (76.5%), water (21.3%)
 - Site is now a parking lot